

**DETERMINING STAFFING NEEDS FOR INITIAL RESPONSE TO
EMERGENCY INCIDENTS**

EXECUTIVE ANALYSIS OF FIRE SERVICE
OPERATIONS IN EMERGENCY MANAGEMENT

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An applied research project submitted to the National Fire
Academy as part of the Executive Fire Officer Program.

October 1997

Abstract

The purpose of the study was to determine the number of firefighting personnel necessary on the scene of an emergency incident within an appropriate time frame to begin performing fire, rescue and emergency services at Dallas/Ft. Worth International Airport (DFW).

The study used an evaluative research methodology. The research questions were:

1. What is the maximum time to have all operational firefighting personnel on the scene of an emergency?
2. What is an appropriate number of firefighting personnel on the scene of an emergency incident?
3. How many firefighting personnel are typically dispatched on an emergency incident at DFW Airport?
4. What are the consequences of not properly staffing the initial response to an emergency incident with enough firefighting personnel?

Due to the unique nature of the emergency services delivery system employed at the DFW Airport's Department of Public Safety, procedures were developed to collect the research data necessary to answer the research questions. Three scenarios were developed that simulated a vehicle accident, a structural fire, and an aircraft fire accomplished on multiple occasions, each time adding additional firefighting personnel. The outcomes of the scenarios were measured in minutes and seconds to evaluate effectiveness and efficiency of initial response crews by number.

Additional research was conducted to determine industry accepted time frames for responders to arrive and begin rescue and firefighting activities on both structural and aircraft emergencies.

The results of the research determined that appropriate initial response found acceptable for departments similar in size to the DFW Airport's Department of Public Safety to be between 16 and 24 firefighters arriving on the scene of working fires in no less than 5 minutes for structural emergencies and no less than 4 minutes for aircraft emergencies.

This research concluded that the department needed to employ and train an additional 74 firefighters in order to staff existing apparatus and to provide for minimum standard initial response within the numbers determined by this research.

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INTRODUCTION

The number of people necessary to perform a particular task has plagued administrators and organizations from the earliest time that people came together to accomplish work in a combined effort. Fire Departments and Public Safety organizations such as the Dallas-Fort Worth International Airport's Department of Public Safety (DFWDPS) are no exception. As a Division Commander for the DFWDPS and charged with the responsibility of managing the Fire Rescue Division, I am intimately aware of the concern for determination of an appropriate level of staffing for firefighting operations.

One problem with determination of staffing is that there are only limited references to draw upon to make sound decisions based on expertise outside individual organizations. That direction is even more rare given the unique requirements of the Department of Public Safety.

The purpose of this applied research is to determine the appropriate number of firefighting personnel on the scene of an emergency incident within an appropriate time frame to begin performing fire, rescue and emergency services at Dallas Fort Worth International Airport (DFW).

This study uses an evaluative research methodology. The research questions are:

1. What is the maximum time to have all operational firefighting personnel on the scene of an emergency?
2. What is an appropriate number of firefighting personnel on the scene of an emergency incident?

3. How many firefighting personnel are typically dispatched on an emergency incident at DFW Airport?
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BACKGROUND AND SIGNIFICANCE

The Dallas Ft. Worth International Airport (DFW) was established in 1973. Since opening, it has grown significantly and promises to grow at a faster pace over the coming years. This growth is expected to translate into more police, fire and EMS related calls for service.

The Department of Public Safety at Dallas/Ft. Worth International Airport is an organization responsible for airport emergency services. The department is comprised of 320 crosstrained police and firefighting personnel and clerical staff. The Fire-Rescue Division is comprised of 117 cross trained police and firefighting personnel who are primarily responsible for fire protection of aircraft and support facilities. The division is managed by 1 Division Commander (Captain), 10 Shift Commanders (Lieutenant) and 20 Station Officers (Sergeant). The other 86 personnel are assigned as driver/operators for the division's apparatus fleet.

The Fire-Rescue Division provides its service from 4 fire stations. The division staffs 17 first line apparatus, both aircraft rescue and structural, during peak aircraft operation times (from 0700 hrs.

till 2300 hrs.) and 13 apparatus during off peak aircraft operation times (from 2300 hrs. till 0700 hrs.).

The division also staffs a 4 person squad that responds to all incidents for manpower.

The Fire-Rescue Division is supported by the Patrol Division who is responsible for police patrolling of the airport in squad cars. Additionally, they are responsible for responding to fire related calls in the capacity of firefighter and rescuer. The Patrol Division is staffed with 34 crosstrained personnel. The personnel assigned to the Patrol Division respond to fire related emergencies as they become beyond the capacity of the Fire Rescue Division to handle within the previously listed resources. Upon arrival, the Patrol Officer dons protective clothing assuming a firefighting role. Typically, the Patrol Division staffs 5 units and provides no less than a 5 person complement on a 24 hour basis.

Given this method of service delivery, fireground staffing for initial response to emergency incidents are as follows. A structural emergency will cause 9 personnel to be dispatched on 6 vehicles. An aircraft emergency will cause 10 firefighters to be dispatched on 7 vehicles. A vehicle emergency will cause 5 firefighters to be dispatched on 4 vehicles.

The method of providing police and firefighting services in the traditional DFWDPS method has been effective during the previous years due to low call volume. However, with the increase of call volume over the most recent years and the understanding that call volume will continue to increase, it is believed that both divisions will reach a saturation point and this method will become increasingly

ineffective. This is not only significant to the Fire Rescue Division in that as call volume increases in the fire service, it impacts the Patrol Division's ability to provide its additional responsibility of policing the airport. The result is that both police and fire protection indirectly suffer in terms of efficiency and effectiveness.

Numerous subjects studied in the National Fire Academy's course work titled, "Executive Analysis of Fire Service Operations in Emergency Management", are closely related and relevant to this research topic. Those topics include, but are not limited to, the chapters on "Emergency Operations", "Incident Command System", and "Emergency Operations Center". However, the chapter that is most closely related to the research topic is "Capability Assessment".

The topic of study identified as Capability Assessment stated enabling objectives to include the identification of capability shortfalls in a typical community and to develop methods to obtain critically needed resources.

Literature Review

The challenge for Public Administrators and for this particular research project is to balance levels of service and the economics associated with the level of service preferred. "The foremost question of interest is what mix of staffing levels and response times will provide the greatest suppression benefit for the lowest cost." (International City Management Association [ICMA], 1988). It is an

understood concept that each organization wrestles with the question of staffing and although each organization has their own unique concerns, all have a common goal. That goal is providing sufficient service for the lowest investment.

In determining the necessary staffing for an organization like a fire department, questions must be asked and researched. Many organizations have asked, How many firefighters should be assigned to engines and trucks? This question is an important one, but due to the emergency services delivery system at DFW Airport is not a critical element in establishing staffing at the scene. It does however closely relate to the subject matter of this research topic and therefore will be addressed.

A more significant series of questions for DFW Airport and DFWDPS are, “What is a reasonable amount of time for firefighting personnel to arrive on the scene of a working fire and begin fire and life saving operations?”, “How many firefighting personnel should arrive on the scene of a working fire in a reasonable amount of time?”, and finally, “What happens if firefighters arrive later than projected and without sufficient staffing?”

The question regarding staffing assigned to engine and truck crews is the easiest to substantiate due to the amount of research and experimentation available on the topic. Many organizations and private consultants have provided research on the subject of crew staffing of engine and truck companies. The City of Dallas, Texas commissioned an independent study in 1984 known as the “Dallas Fire Department Staffing Level Study.” The focus of this study was of efficiency and

effectiveness of crews by size, or number of firefighters assigned to engine and truck companies. The private consultants were tasked with balancing the critical issues of determining appropriate levels of staffing while being sensitive to the economic impacts associated with a potential increase in staffing. The authors state, “An evaluation of staffing levels for fire company crews involves careful analysis of the effects of reducing staff, in terms of accomplishing the objectives of fire control, saving lives and property and adequate safety precautions for the fire control staff.” (McManis and O’Hagan, 1984). The report continues by outlining the steps they took to draw the conclusions of crew size. They begin, “To create the conditions under which the project team could observe and measure crew effectiveness, using actual performance time as the primary evaluation determinant, three simulation scenarios and a full-scale fire scenario were developed. In each of these tests, particular events were identified which were critical to the success of the operation. These included: rescuing trapped victims, placing a hose line into operation, and providing openings to relieve a building of heat and toxic gases. Times for completing these tasks were recorded to compare the effectiveness of the different size crews. As a general rule, our study indicates that staffing below a crew size of four can overtax the operation force and lead to higher losses.” (McManis and O’Hagan, 1984).

Other studies have been accomplished since that time with similar or identical results. The City of Austin Fire Department conducted a similar study in 1994. The Austin Fire Department found, “Yet another study has proven that four-person fire company staffing is both safer and more efficient than three firefighters per crew. The study reviewed actual firefighter injury rates in Austin over the past four years and found a significantly lower rate for four-person crews. These findings—that the rate of injury is

inversely related to staffing levels-confirm an International Association of Firefighters (IAFF) study completed in 1991 and they are consistent with earlier studies conducted by the IAFF and other researchers.” (“Austin Beefs Up,” 1994).

The first research question to be answered through the review of literature is. “What is an appropriate time frame for arrival of rescue and firefighting crews on a working fire”. Here again, specific reference to time frame is not readily available and dependant largely on the specific geographic location and other variables. Rural areas are certainly subject to greater response times due largely to travel distances. But here again, certain specific reference can be found and a conclusion can be drawn from related subjects of study.

Most municipal fire departments are satisfied with a five minute response time to structural emergencies. The consultant completing the Dallas Fire Department Study used this rule of thumb principle for the purposes of that study. The study states, “In the fire simulations, the time for commencing fire department operations was taken as five minutes after fire ignition. This time frame allowed for a representative approach to the tests for the sake of consistency.” (McMannis and O’Hagan, 1984).

The Federal Aviation Administration (FAA) has more specific detail with regard to appropriate time frames to arrive on the scene of an aircraft emergency, but the regulation fails to be specific about the number of firefighting personnel necessary on the scene. Specifically, the federal regulation states,

“Within three minutes from the time of the alarm, at least one required airport rescue and firefighting vehicle shall reach the midpoint of the farthest runway serving air carrier aircraft from its assigned post...and begin application of foam, dry chemical or halon 1211. Within four minutes from the time of alarm, all other required vehicles shall reach the point...from their assigned post and begin application of foam, dry chemical, or halon 1211.” (Federal Aviation Regulation, 1988).

From the previous guidelines and recommendations, this research concludes that five minutes for crews to arrive and begin operations on structural emergencies are acceptable. Furthermore, it concludes that four minutes for crews to arrive and begin operations on aircraft emergencies are required.

The next question to be answered is, “How many firefighters are necessary on the fireground in order to accomplish the critical tasks previously listed as, controlling the fire, saving life and property and providing for safety of firefighters”.

The International City Management Association states that, “Various controlled and statistically based experiments by some cities and universities reveal that if about 16 trained firefighters are not in operation at the scene of a working fire within the critical time period, then dollar loss and injuries are significantly increased, as are the square feet of fire spread.” (ICMA, 1988).

A study submitted to the Federal Emergency Management Agency (FEMA) was researched by

a private consultant. The consultant, Centaur Associates, Inc., provided a document titled, “Report on the Survey of Fire Suppression Crew Size Practices” The report is a comprehensive review of surveys conducted of 171 cities with a population of >100,000. The report describes the results of a survey conducted by the FEMA of existing crew size and standard initial response practiced in cities of at least 100,000 population.

While DFW Airport has no official population, it does have a high number of persons passing through the airport on a daily basis. These customers of the airport are perceived in the same regard as a population for purposes of this research. Based on 1996 passenger activity, DFW Airport has an average of 161,643 passengers traveling the airport terminals on a daily basis. This does not include airport, airline or other ground transportation type users of the airport which would increase the population beyond 200,000 daily. (Dallas/Fort Worth International Airport-Business Activity Report, 1996).

The FEMA document reports that the “Average range of engine company staffing as 3.6 firefighters and ladder company staffing as 3.6 firefighters”. The report also surveyed the cities “standard initial response” to different occupancies. The report defines, “Standard initial response is the complement of men and equipment dispatched to answer an alarm for a given location or occupancy.” (Centaur Associates, 1982).

With respect to “Standard Initial Response”, the report details the number of firefighters

responding and further breaks down the responders by occupancy type. The breakdown of the average number of firefighters responding to the associated occupancy types are Single Family, Multiple Dwelling, High-Rise, Commercial, and Hospital. Included in table 1 is the standard initial response for aircraft emergencies at DFW Airport (Centaur Associates, 1982). This report did not include aircraft and the entry is made for comparative reference only.

Table 1

Comparison of Average Number of Firefighters on Initial Response Survey Average Versus D/FW Response						
	Single	Multi	High Rise	Comm.	Hospital	Aircraft
Survey	15.1	16.9	21.1	18.4	21.8	0
D/FW	0	0	9	9	0	10

While a single family dwelling, multiple dwelling or a hospital are not located on the airport's property and was not reported in the table, the airport does have a high-rise hotel and many commercial buildings. In comparison, the Fire Rescue Division responds less than half the firefighters to a high rise building and to a commercial building. While the survey did not include any aircraft related emergency responses, it could be said that the nature of an aircraft emergency could be compared to a high-rise, hospital or commercial building.

Reports and studies, Dallas Fire Department Staffing Level Study and Austin Fire Department Staffing Level Study to name two, have concluded that four person engine crews and five person truck companies are the safest and most efficient crew size. These departments typically respond 3 engines, 2 truck companies and 2 command level officers to a fire. These 7 units arrive and place 24 firefighters

on the fireground. From these statistics, this research can conclude that these departments find that 24 firefighters are necessary on the fireground for the safe handling of a working fire.

To summarize what this review of literature has provided so far, it has concluded that departments should staff engine crews with 4 firefighters, and truck crews with 5 firefighters. Departments should provide 16 to 24 firefighters on the fireground for working fires and should have all working firefighters arrive within 5 minutes for structural emergencies and 4 minutes for aircraft emergencies.

The next question to answer is what will happen if departments fail to provide the resources and personnel necessary for effective mitigation of fire emergencies. Several consequences can be predicted should manpower needs not be met.

The first consequence is one of effectiveness or efficiency. Numerous studies have been completed by both partial and non-partial parties that all concluded similar findings with regard to staffing for fireground operations. Should a department choose to ignore those facts, it is only logical to assume that a department's ability to be effective/efficient will be reduced. Effectiveness and efficiency on the fireground translates to losses in property and life. This situation is most evident in smaller communities who have less economic resources to provide for fire protection. The ICMA reports, "Smaller communities often suffer disproportionately large fire losses because of their apparent inability to maintain sufficient initial attack suppression forces." (ICMA, 1988).

Another consequence associated with under staffing a fireground operation is firefighter deaths and injuries. A study conducted by the International Association of Firefighters stated, "Firefighters in companies of less than four are one third more likely to get killed or injured on the job, according to a new study of 63 cities released by the International. The study joins a growing library of evidence from a diverse array of sources, all proving that four-or-more member fire companies are safer, more cost effective, and better at handling emergencies." ("IAFF Study Shows," 1992).

The study in Austin, Texas in 1994 found that “the rate of injury is inversely related to staffing levels.” (IAFF Study Shows,” 1994). The Alliance for Fire and Emergency Management (AFEM) reported that, “The statistics on fireground injuries tell us that over the past ten years, nearly one million firefighters have been injured in the line of duty. Of that 95,000 to 105,000 reported annual injuries, over half have been injuries that occurred during emergency operations. These injuries can be directly related to firefighter fatigue. As our firefighters become more tired during an incident, their potential for injury increases. Many times we think that, with the apparatus on hand, the incident can be controlled. We sometimes don’t recognize, however, that apparatus do not extinguish fires-manpower does. If there are more tasks to accomplish than there are people available to perform them, then more resources (personnel) are needed at the scene. If there are just enough people available to accomplish the designated tasks, you still need additional personnel to allow for rehabilitation and staging. Our people and their safety are our first priority, our most valuable resource and our primary concern.” (Laford, R. F., 1996).

Deaths and injuries can not only be personally and professionally devastating for firefighters, but they also present a significant financial impact to fire departments. Workman’s compensation claims and overtime to cover for firefighters who find it necessary to miss work is extremely expensive.

Beyond the moral issues, what does it mean legally to an organization who must make decisions on adequate staffing? Legal issues affecting departments are rarely clear cut and staffing is no exception. However, several critical legal issues must be understood.

The first legal understanding is the impact of the National Fire Protection Association (NFPA). While the NFPA does not have the power to write law it is recognized throughout the country as an industry standard. The daily newspaper in Washington D.C. reported that, “The standards developed by the NFPA are not legally binding to localities. However, cities can expect to confront such nationally adopted standards in litigation, collective bargaining and perhaps workers compensation hearings.” (Walton, 1997). While the NFPA makes no specific reference to the number of firefighters necessary

for a fireground operation, it does make many specific references to staffing requirements for specific tasks. For instance it dictates that two-firefighters are required on each attack line and that a two-firefighter rapid intervention crew should be available to rescue injured or lost firefighters. When these multiple references to staffing are put together on a fireground, the number of firefighter resources varies by incident.

The National Institute for Occupational Safety and Health (NIOSH) also plays a role in insuring that issues of firefighter occupational safety are met. The National Fire Protection Association reported that, "President Clinton's proposed budget for fiscal 1998 includes \$2.5 million for the NIOSH to conduct investigations for firefighter line-of-duty deaths and to develop injury prevention methods." ("Firefighter Injury and Death Study," 1997).

Actual court cases illustrate a variety of creative claims. "In the City of Hammond, Indiana vs. Catalidi, it was alleged that a fire service organization acted negligently when it failed to maintain enough firefighters to operate the equipment it intended to use." (Posner, 1997).

PROCEDURES

In completing the review of relevant literature to research the number of firefighters on the fireground to perform efficiently, effectively and safely, I discovered many relevant, but no specific documentation, to draw a conclusion(s). I found it necessary to duplicate other's efforts to determine need for staffing based on the unique requirements of the Dallas Fort Worth International Airport. Therefore, the following procedures outline an experiment to determine staffing needs.

A team was assembled to identify specific target hazards that were unique to the airport. It was communicated that a realistic approach to the identification of target hazards was necessary. At DFW Airport, like in every community, the potential for a monumental disaster is always a possibility. However, understanding that the economic feasibility of staffing for a monumental disaster was not

likely, the team set about evaluating some realistic likelihoods.

The eventual result of the step to identify target hazards ended with three scenarios that have been handled by the Department of Public Safety on numerous occasions. Those scenarios were a vehicle fire, a multi-level structure fire and an aircraft interior fire. Scenarios were developed for each of the three incidents designed to be realistic representations of past incidents, be challenging while not overwhelming and to be capable of measuring performance.

The vehicle accident scenario was a single car that included a trapped victim requiring handline deployment for protection, vehicle stabilization, rescue tool operation for access to driver's door, and victim removal. It was assumed that no fire had occurred during this scenario. This type of situation occurs frequently at DFW Airport.

The structural scenario was a simulated fire on the third level of a type 1A constructed building. The fire was simulated to be a small fire within the HVAC duct system. The tasks required for this scenario were to attack the fire with a single handline, support the structures fire suppression system, provide for a rapid intervention crew for firefighter safety, ventilate the affected area, and conduct a primary and secondary search.

The aircraft scenario was a small simulated fire in the galley of a commercial aircraft. The simulation was designed to re-enact numerous situations that have occurred at DFW Airport. The scenario required the evacuation of passengers and crew, the entry of a single attack team for victim search and fire extinguishment, and a rapid intervention crew for safety. A description of the scenarios are attached. (see Appendix A)

Each scenario was conducted at the department's fire training facility and all three scenarios were done three times. The first of each scenario was conducted with the number of firefighters currently responding to calls of the individual nature based on response requirements. The second time a scenario was conducted, two additional firefighters were added to the initial response. The third time

a scenario was conducted, two additional firefighters were added to the response. On the third and final scenario the incident manager would manage the call with four additional firefighters over the normal minimums. A step by step procedure for each of the three scenarios is also attached. (See Appendix B, C, and D).

The limitations of the scenarios were as follows. All the incidents were conducted on the same day and represent a single attempt at identifying times that were used in the final calculation. The use of several identical incidents conducted over the course of several days would have resulted in average times that may more accurately represent actual times. However, the availability of personnel to conduct the experiment and the availability of the training facility, made this manner of collecting the additional data difficult.

It is recognized that the conducting of identical scenarios consecutively on three occasions, could result in some improvement of times based on the participant's ability to cut time off of the scenario by learning to do a specific task better after each attempt. This concern was specifically addressed in a pre-scenario briefing to attempt to limit the chances of this occurring. Additionally, between each scenario the participants were reminded to move at the same speeds as were demonstrated on the first scenario and to duplicate mistakes that may have caused additional time the first scenario. The purpose of this was to insure that improvements or decreases in scenario times were representative of adding additional staffing and not due to the increased proficiency of firefighters through the correction of mistakes in performance.

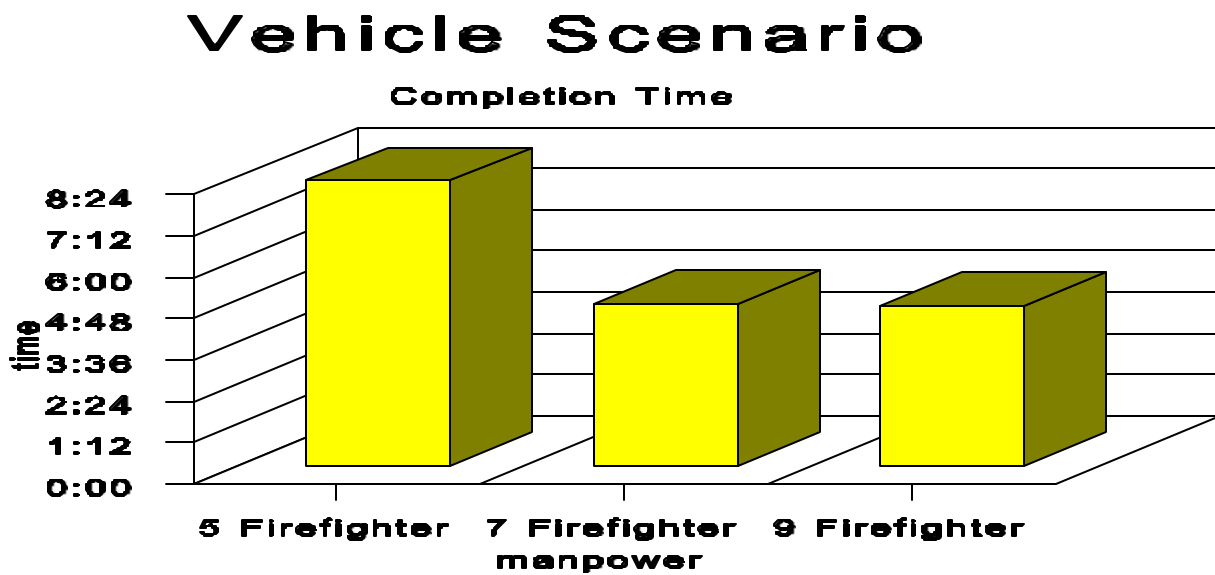
Additionally, the scenarios were only representative of three scenarios. While many different scenarios could have been included, the scenarios were limited to three of the most common incidents for the purposes of time and firefighter fatigue.

Results

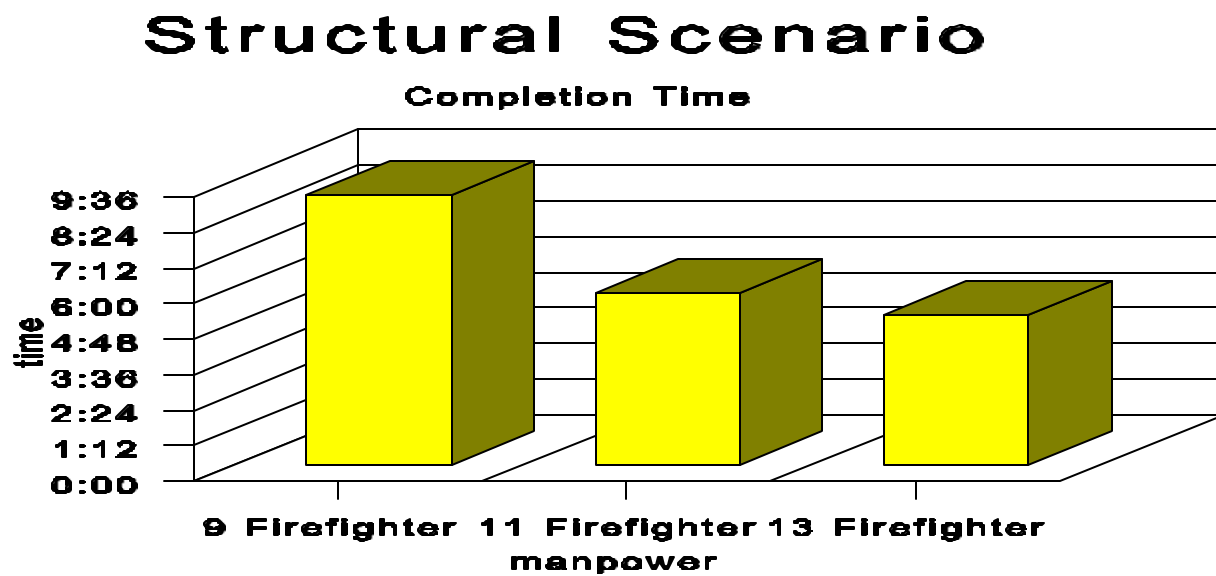
The research question of appropriate number of firefighting personnel on the scene of an emergency is relative to the type of emergency and answered most specifically by the experimental scenarios. The answers provided are those believed by the author of this report and are based on my personally understanding of acceptable versus unacceptable performance.

The first scenario evaluated was the vehicle accident. The total evolution time for the standard 5 firefighter response was 8:19 min/sec. The second attempt of the evolution with 7 firefighters resulted in a 4:45 min/sec. evolution time. Finally the third attempt with 9 firefighters was conducted with a total evolution time of 4:40 min/sec. (see Appendix E).

The second attempt of the vehicle scenario with 7 firefighters resulted in a 42.8% increase in efficiency. The third attempt of this same scenario with 9 firefighters resulted in a decreased scene time of 5 seconds over the second scenario and due to negligible difference was not regarded as valuable. This scenario resulted in an obvious efficiency increase when conducted with 7 firefighters and therefore is regarded as the optimum staffing level of scenarios of this type. (see Figure 1A).



The second scenario evaluated was the structural evolution. The total evolution time for the standard 9 firefighter response was 9:06 min/sec. The second attempt of the evolution with 11 firefighters resulted in a 5:49 min/sec. evolution time. Finally, the third attempt with 13 firefighters was conducted with a total evolution time of 5:03 min/sec. (see Appendix F).

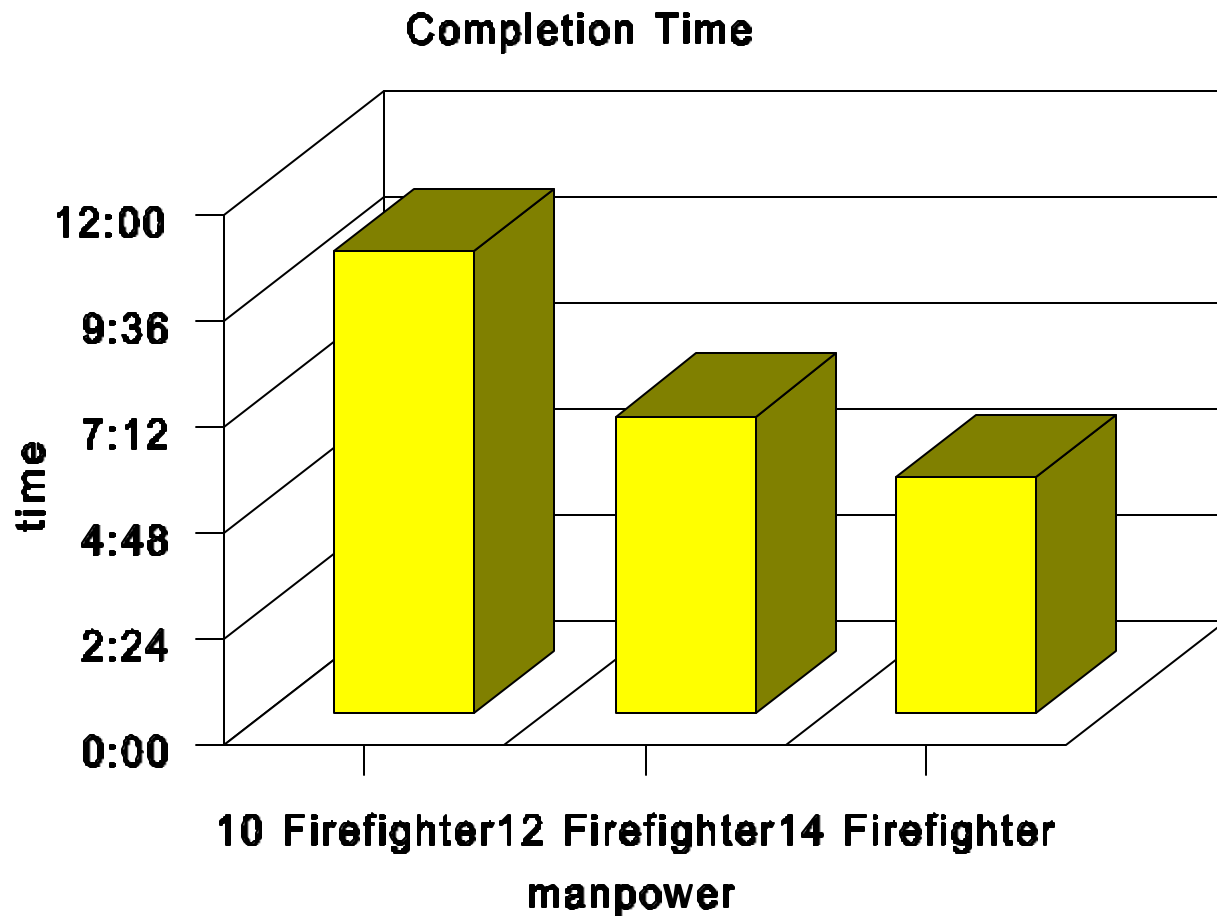


With regard to staffing a structural emergency, the scenario yielded a significant increase in efficiency when conducted with 11 firefighters but also demonstrated a measurable increase when conducted with 13 firefighters. The second attempt resulted in a 4:17 min/sec. decrease in scene time that represents a 36% increase in efficiency. The third attempt resulted in an additional 36 seconds off the scene time and an overall increase in efficiency of 44%. The increase in efficiency of 44% is significant and therefore 13 firefighters are optimum for this type of emergency incident. (see Figure 1B).

The third scenario evaluated was the aircraft fire evolution. The total evolution time for the standard response of 10 firefighter response was 10:30 min/sec. The second attempt of the evolution with 12 firefighters resulted in a 6:45 min/sec. evolution time. Finally, the third attempt with 14 firefighters was conducted with a total evolution time of 5:22 min/sec. (see Appendix G).

With regard to staffing an aircraft emergency, the scenario yielded a significant increase in efficiency when conducted with 12 firefighters and a more dramatic increase when conducted with 14 firefighters. A decrease in scene time of 3:45 was documented on the second attempt resulting in a 35.7% increase in efficiency. An additional decrease of 1:23 min/sec. on the third scenario translates to an overall increase in efficiency of 48.8% when responding with 14 firefighters. Due to the significant increase in efficiency when responding with 14 firefighters, this number is regarded as optimum for this type of incident. (see Figure 1C).

Aircraft Scenario



The research question as to the time frame for operational forces to arrive on scene and be placed into service has been determined to be 5 minutes for structural emergencies and 4 minutes for aircraft emergencies.

The research question as to the consequences of not properly staffing fireground operations are issues of economic impact, effectiveness/efficiency, legal impact and workplace safety and have been reviewed in the literature review.

DISCUSSION

The findings of this study are consistent with those results of similar studies. As already documented, numerous studies have determined the need for firefighting personnel in excess of the current firefighter complement normally dispatched to emergency incidents at DFW Airport.

Collectively the number of firefighters other agencies dispatch to situations similar to those described previously are between 16 and 24. These numbers are greater than those experimented with during these scenarios and should be further considered for future experiments. Obviously, more tasks can be performed in a shorter time frame if enough personnel are available to conduct the tasks simultaneously. For this reason, it is absolutely necessary that additional firefighting forces are dispatched initially to maximize the positive outcome.

The organizational implications of this modification to current response procedures range from elementary to complex. Additional response personnel can be dispatched initially within current authorized staffing. Two options are available for immediate implementation.

Option one requires the dispatch of additional apparatus within the Fire Rescue fleet from other remote locations (Fire Stations) on the airport. This option will increase the response time as travel distances will be greater for these additional apparatus from the remote locations. The airport encompasses 25 square miles of physical property. Each of the four existing stations is responsible for protection of approximately 6.25 square miles of property within it's assigned district. Response beyond the assigned district and the adjoining district would be necessary and due to the distances would not provide initial responders on scene within the time frame identified by this research.

Option two requires the dispatch of additional Patrol Division personnel within the existing staffing. This option will enhance the number of initial responders but not meet the standard demonstrated by other departments of similar size. Additionally, it will greatly reduce the police

presence in the field while units are responding to fire related emergencies. A 5 person/squad complement would be greatly compromised by the necessity of the dispatch of Patrol Officers to meet the minimum response requirement.

Another less immediate option to the ones previously discussed would require the hiring of additional staffing and assigning of those additional human resources to existing apparatus. This would require the hiring of 74 new personnel to staff 4 existing engines with 3 firefighters and 2 existing aerals with 4 firefighters. This number includes personnel for all shifts to include a relief factor of 2.0. This option will require in excess of \$3.1 million annually to pay for salaries and benefits.

Recommendations

Three options were discussed. The only option discussed that meets the goal identified by this research is the third option. This option will cause a standard initial response of 16 to 24 firefighters insuring an on scene time in under 5 minutes for structural emergencies and under 4 minutes for aircraft emergencies.

Based on the facts and results of this research document, I recommend that the Dallas Fort Worth Airport's Department of Public Safety, seek to employ additional personnel to assign to existing apparatus. While this option is the most expensive solution, it is the only solution to providing adequate staffing for fireground operations within the targeted time frame.

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Appendix A**Emergency Incident Experiment's****AIRCRAFT FIRE EXPERIMENT**
utilizing 10, 12, & 14, personnel

This Experiment began with a standard complement of firefighters dispatched to an aircraft alert (10 firefighters). The situation is that units are at the predetermined standby points when the aircraft touches down and rolls out, the pilot stops on a taxiway, pops the chutes and begins to evacuate the aircraft. During evacuation, the pilot advises that a flight attendant has found the fire in the trash chute in the forward galley. The units converge on the aircraft and initiate rescue and firefighting operations. Several experiments were conducted to determine the times it took to:

- * Rescue the passengers.
- * Locate, Confine, & Extinguish the fire.
- * Deploy Attack line and a Back-up line.
- * Provide Safety personnel.

STRUCTURAL FIRE EXPERIMENT
utilizing 9, 11, & 13 personnel

This Experiment began with our standard complement of firefighters dispatched to an automatic alarm (9 firefighters). The situation begins with the firefighters responding to a fire alarm. The first unit on the scene reports smoke showing. The units initiate firefighting activities. Several experiments were conducted to determine the times it took to:

- * Connect to building fire protection systems.
- * Conduct primary search.
- * Deploy attack and back up lines.
- * Provide for building ventilation.
- * Provide Safety personnel.

BASIC VEHICLE EXTRICATION EXPERIMENT
utilizing 5, 7, & 9 personnel

This experiment began with a major accident with one person trapped inside a vehicle, extrication required. There is a concern for leaking fuel and a potential for fire. Several experiments were conducted to determine the times it will took to:

- * Deploy protective hose line.
- * Set up hurst tool.
- * Extricate the victim.

Appendix B

Step by Step Procedure for Staffing Experiments

This checklist can be used to keep times for starting and completing activities for each **VEHICLE ACCIDENT SCENARIO**.

The scenario starts with:

- * 5 (7 or 9) responders, composed of 1 Lt., 1 Sgt. in a rescue vehicle, 1 engine & operator, and 2 (4 or 6) firefighters.
- * The Fire Rescue Lt. will serve as COMMAND and the ISO.
- * All equipment & personnel start out on the scene as if they had just arrived
- * All personnel on the scene are bunkered out standing by their assigned vehicles;
- * COMMAND has been established and will order:
 - * the engine to prepare for a protective hose line operation.
 - * the Sgt to stabilize the vehicle and initiate a hurst tool operation to “pop the door”.
 - * a team (or firefighter) to deploy & charge the protective hose line.
 - * a team (or firefighter) to assist the Sgt in extrication.
 - * a team to be the RIC team.

*NOTE: MULTIPLE TASKS MAY BE ACCOMPLISHED DEPENDING ON THE NUMBER OF FIREFIGHTERS AVAILABLE.

START: The scenario starts when COMMAND gives the size-up makes the first assignment.

COMMAND: “20 is on with a major accident, with only one victim and he is pinned in, possible gasoline leak, vehicle is off the road; 40 is Rescue Branch. 40 stabilize the vehicle and prepare the hurst tool for operation. Eng 1 set up for a protective line. (Make other assignments as personnel available)

STEP 1. Vehicle is stabilized.

STEP 2. Protective hose line in operation.

STEP 3. Hurst tool in operation.

STEP 4. A RIC team is in place.

SCENARIO ENDS when all possible steps are completed.

Appendix C

Step by Step Procedure for Staffing Experiments

This checklist can be used to keep times for starting and completing activities for each STRUCTURAL SCENARIO.

The scenario starts with:

- * 9 (11 or 13) responders, composed of 1 Lt., 1 Sgt., 2 engines & operators, (1 simulated aerial truck & operator,) and 4 (6 or 8) firefighters.
- * The Fire Rescue Lt. will serve as COMMAND, FIRE CONTROL, and the ISO.
- * Engine 1 starts out standing by the hydrant on landside; engine 2 arrives 3 minutes later since it is called to landside from the AOA standby position.
- * All personnel on the scene are bunkered out standing by their assigned vehicles.
- * COMMAND has been established and will order:
 - * All firefighters to assemble near unit 40 for assignments.
 - * Engine 1 to lay a supply line and connect to the appropriate FDC.
 - * Sgt to take a team to the 3rd floor, deploy a hose line from high rise pack.
 - * Force entry, perform primary search, and locate & extinguish the fire.
 - * A team to take a PPV fan to level 3 for ventilation.
 - * A team to provide a back-up line.
 - * Set up the accountability system.
 - * A team to be the RIC team.
 - * Perform secondary search.

* NOTE: MULTIPLE TASKS MAY BE ACCOMPLISHED DEPENDING ON THE NUMBER OF FIREFIGHTERS AVAILABLE. EACH TEAM WILL REPORT TO COMMAND UPON COMPLETING THEIR ASSIGNED TASK.

START: The scenario starts when COMMAND gives a size-up and makes the first assignment.

COMMAND: “20 is on with a three story terminal building, smoke showing from the roof area of level 3. 40 will be Attack Branch. All personnel assemble in a resource staging area near unit 40 and standby for assignment. 40, your tactical objective is search & rescue as necessary, force entry, and attack the fire. Eng 1, lay a line and connect to the FDC.

STEP 1. Engine connected from hydrant to FDC and charges the system.

STEP 2. A team deploys a high rise pack hose line on level 3 and flows water.

STEP 3. A team sets up an operating PPV fan on level 3.

STEP 4. A Back-up Team is in place on level 3 with charged line.

STEP 5. A RIC team is in place.

SCENARIO ENDS when all possible activities are completed.

Appendix D

Step by Step Procedure for Staffing Experiments

This checklist can be used to keep times for starting and completing activities for each AIRCRAFT SCENARIO.

The scenario starts with:

- * 10 (12 or 14) responders, composed of 1 Lt., 1 Sgt., 2 ARFF trucks & operators, (2 more simulated ARFF trucks & operators,) and 4 (6 or 8) Firefighters.
- * The Fire Rescue Lt. will serve as COMMAND, FIRE CONTROL, and the ISO.
- * All vehicles “set up” on the stopped aircraft.
- * All firefighters are bunkered out standing by their assigned vehicles.
- * COMMAND has been established.
- * The Sgt will be assigned the role of Rescue/Attack Branch. All available firefighters will be assigned to the Sgt. The Sgt. has the responsibilities of :
 1. Assisting in the evacuation of the aircraft via the chutes.
 2. Getting the L-1 door laddered.
 3. Locating, attacking, & extinguishing the fire.
 4. Getting a back-up line in place on the rear stairs for safety.

* NOTE: MULTIPLE TASKS MAY BE ACCOMPLISHED DEPENDING ON THE NUMBER OF FIREFIGHTERS AVAILABLE.

START: The scenario starts when COMMAND informs all firefighters that the aircraft has fire in the front galley and he has stopped on the runway and is “popping the chutes” for an evacuation. “COMMAND to all personnel, 40 is Rescue/Attack Branch, all firefighters meet with 40 for assignments. 40, your tactical objective is rescue, ladder the aircraft, get a fire attack line in operation, and a back-up line on the rear stairs”.

STEP 1. At least one firefighter is positioned at each chute to assist in the evacuation of the passengers. It is assumed no passengers require further assistance. This step is automatically over 2 minutes into the scenario. This is the average time required by the FAA to evacuate an aircraft.

STEP 2. A team ladders the L-1 door.

STEP 3. A team attacks and flows water onto the fire.

STEP 4. A back-up team is in place with charged line.

SCENARIO ENDS when all possible activities are completed.

Appendix E

VEHICLE EVOLUTION

NO. OF PARTICIPANTS	5	7		9	
START OF EVOLUTION	0:00	0:00	-----	0:00	-----
COMMAND ASSUMED BY LT.	:33	:28	-:05	:30	-:03
PROTECTIVE HOSELINE IN PLACE	2:03	1:42	-:21	1:47	-1:30
HURST TOOL DEPLOYED	2:50	1:45	-1:05	1:20	-1:30
VEHICLE STABILIZED	2:50	1:53	-:57	1:30	-1:11
HURST TOOL OPERATIONAL	3:24	2:09	-1:15	1:30	-1:54
VICTIM REMOVED	8:19	4:45	-3:34	4:40	-3:39
EVOLUTION STOP TIME	8:19	4:45	-3:34	4:40	-3:39
INCREASE IN EFFICIENCY		+42.8%		+43.8%	

Appendix F

STRUCTURAL EVOLUTION

NO. OF PARTICIPANTS	9	11		13	
START OF EVOLUTION	0:00	0:00	-----	0:00	-----
COMMAND ASSUMED BY LT.	:45	:29	:-20	:28	:-21
ATTACK BRANCH	:52	:39	:-13	:34	:-18
WATER SUPPLIED TO FDC	5:35	3:03	-2:32	2:06	-3:29
ATTACK TEAM RETRIEVES HIGH	1:48	1:07	:-41	:50	:-58
BACKUP CREW RETRIEVES HIGH	3:19	3:20	+:01	2:51	:-28
HOSELINE BLED	6:54	5:47	-1:07	4:50	-2:04
RIC IN PLACE	6:56		-----	1:37	-5:19
VENTILATION STARTED	8:46	5:07	-3:39	4:15	-4:31
ATTACK CREW FLOWING WATER	6:00	4:52	-1:08	4:05	-1:55
ISO ASSIGNED	N/A	N/A	-----	N/A	-----
ACCOUNTABILITY OFFICER	N/A	N/A	-----	N/A	-----
EVOLUTION STOP TIME	9:06	5:49	-3:17	5:03	-4:03
INCREASE IN EFFICIENCY	-----	+36%		+44%	

Appendix G

AIRCRAFT EVOLUTION

NO. OF PARTICIPANTS	10	12		14	
START OF EVOLUTION	0:00	0:00	-----	0:00	-----
COMMAND ASSUMED BY LT.	:50	:40	-:10	:38	-:12
BRANCH ASSUMED/ASSIGNED	:55	:42	-:13	:44	-:11
FIRST FF AT EVAC CHUTE	1:25	1:11	-:14	1:17	-:08
FINAL FF AT EVAC CHUTE	1:50	1:33	-:17	1:45	-:05
ATTACK TEAM DEPLOYS HOSE	5:30	4:30	-1:00	2:30	-3:00
AIRCRAFT LADDERED	6:03	4:30	-1:33	4:20	-1:43
BACKUP TEAM DEPLOYS HOSE	7:30	4:40	-2:50	3:50	-2:40
ATTACK TEAM FLOWS WATER	7:45	6:30	-1:15	5:18	-2:27
BACKUP TEAM FLOWS WATER	8:15	5:20	-2:55	4:30	-3:45
EVOLUTION STOP TIME	10:30	6:45	-3:45	5:22	-5:08
INCREASE IN EFFICIENCY	-----	+35.7%		+48.8%	